

Appl. No. 10/687,183  
Amdt. dated 10/12/2006  
Response to Office Action of 07/12/2006

Attorney Docket No.: TS03-120  
N1085-90157

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**Amendments to the Claims:**

This listing of claims will replace all prior versions and listings of claims in the application:

- 1 1-33. (Cancelled)
- 1 34. (Currently Amended) A copper interconnect structure in a semiconductor device,  
2 comprising:
- 3 (a) a first copper layer having first substantially vertical sidewalls, a planar  
4 bottom, and a concave top surface formed in an opening in a dielectric layer on a  
5 substrate, said first copper layer having a first thickness and a grain density  $G_{D1}$ , said  
6 first substantially vertical sidewalls disposed along sides of said opening; and
- 7 (b) a second copper layer disposed in said opening and having second  
8 substantially vertical sidewalls disposed along said sides of said opening and directly  
9 above and co-linear with said first substantially vertical sidewalls, a substantially planar  
10 top surface that is about coplanar with the top of said dielectric layer, and a convex  
11 bottom surface that forms an interface with said concave top surface of said first copper  
12 layer, said second copper layer having a second thickness and a grain density  $G_{D2}$ .
- 1 35. (Original) The copper interconnect of claim 34 wherein said substrate is  
2 further comprised of an upper etch stop layer and the opening extends through said  
3 etch stop layer.
- 1 36. (Original) The copper interconnect of claim 34 wherein said dielectric layer is  
2 comprised of  $\text{SiO}_2$ , borophosphosilicate glass, or a low k dielectric material that is  
3 fluorine doped  $\text{SiO}_2$ , carbon doped  $\text{SiO}_2$ , a poly(arylether), a polysilsesquioxane,  
4 benzocyclobutene, or a fluorinated polyimide.

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1 37. (Original) The copper interconnect structure of claim 34 wherein the  
2 combined thickness of said first copper layer and said second copper layer is from  
3 about 3000 to 7000 Angstroms.

1 38. (Previously Presented) The copper interconnect structure of claim 34 further  
2 comprised of a conformal diffusion barrier layer formed in said opening along the first  
3 substantially vertical sidewalls and bottom of said first copper layer and along the  
4 second substantially vertical sidewalls of said second copper layer.

1 39. (Currently Amended) The copper interconnect structure of claim 34 wherein the  
2 width of said first copper layer and the width of said second copper layer are  
3 substantially equal and lie within have a range ~~from~~ of about 0.1 microns to over 10  
4 microns.

1 40. (Original) The copper interconnect structure of claim 34 wherein said copper  
2 interconnect has a sheet resistance that is nearly independent of the width of said first  
3 copper layer and the width of said second copper layer.

1 41. (Original) The copper interconnect structure of claim 34 wherein said opening  
2 is part of a pattern that includes a plurality of other openings having a pattern density  
3 and said copper interconnect has a sheet resistance ( $R_s$ ) that is nearly independent of  
4 said pattern density.

1 42. (Original) The copper interconnect structure of claim 34 wherein the first  
2 thickness of said first copper layer is equal to or greater than the second thickness of  
3 said second copper layer.

1 43. (Original) The copper interconnect structure of claim 34 wherein  $G_{D1}$  is  
2 greater than or equal to  $G_{D2}$ .

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1 44. (Original) The copper interconnect structure of claim 34 wherein said  
2 substrate is comprised of a metal layer and said first copper layer of said copper  
3 interconnect is formed above said metal layer and forms an electrical contact to said  
4 metal layer.

1 45. (Currently Amended) A copper interconnect formed in an opening comprised of  
2 a trench formed above a via in a dielectric layer on a substrate, said trench having  
3 trench sidewalls, a bottom, and a width that is larger than the width of said via and said  
4 via having via sidewalls and a bottom, comprising:

5 (a) a first copper layer that fills said via and extends into said trench, said first  
6 copper layer having lower substantially vertical sidewalls and a planar bottom in said via  
7 and first substantially vertical sidewalls that are disposed along said trench sidewalls  
8 and a planar bottom in said trench, a concave top surface formed within the trench, a  
9 first thickness, and a grain density  $G_{D1}$ ; and

10 (b) a second copper layer formed within the trench portion of said opening  
11 and having second substantially vertical sidewalls that are disposed along said trench  
12 sidewalls, a substantially planar top surface that is about coplanar with the top of said  
13 dielectric layer and the top of the trench, and a convex bottom surface that forms an  
14 interface with the concave top surface of said first copper layer, said second copper  
15 layer having a second thickness and a grain density  $G_{D2}$ .

16 wherein  $G_{D1}$  is greater than  $G_{D2}$ .

1 46. (Original) The copper interconnect of claim 45 wherein said substrate is  
2 further comprised of an upper etch stop layer and the via extends through said etch stop  
3 layer.

1 47. (Original) The copper interconnect of claim 45 wherein the combined  
2 thickness of said first copper layer and said second copper layer is from about 3000 to  
3 7000 Angstroms.

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1 48. (Previously Presented) The copper interconnect of claim 45 further comprised  
2 of a conformal diffusion barrier layer formed along the lower substantially vertical  
3 sidewalls and first substantially vertical sidewalls of the first copper layer and the  
4 second substantially vertical sidewalls of the second copper layer and along the bottom  
5 of the first copper layer in the trench and via.

1 49. (Original) The copper interconnect of claim 45 wherein said copper  
2 interconnect has a sheet resistance that is nearly independent of the width of the trench.

1 50. (Original) The copper interconnect of claim 45 wherein said opening is part of  
2 a pattern that includes a plurality of other openings having a pattern density and said  
3 copper interconnect has a sheet resistance ( $R_s$ ) that is nearly independent of said  
4 pattern density.

1 51. (Original) The copper interconnect of claim 45 wherein the first thickness of  
2 said first copper layer is equal to or greater than the second thickness of said second  
3 copper layer.

1 52. (Cancelled)

1 53. (New) The copper interconnect structure of claim 34 wherein said first  
2 substantially vertical sidewalls are conterminous with said sides of said opening and  
3 said second substantially vertical sidewalls are conterminous with said sides of said  
4 opening.

1 54. (New) The copper interconnect structure of claim 45 wherein said first  
2 substantially vertical sidewalls are conterminous with said trench sidewalls and said  
3 second substantially vertical sidewalls are conterminous with said trench sidewalls.